

Utilization of Lightweight Materials made from Coal Gasification Slags

**Quarterly Report
September 1 - November 30, 1996**

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1.0 PROJECT OBJECTIVES, SCOPE AND DESCRIPTION OF TASKS

1.1 Introduction

Integrated-gasification combined-cycle (IGCC) technology is an emerging technology that utilizes coal for power generation and production of chemical feedstocks. However, the process generates large amounts of solid waste, consisting of vitrified ash (slag) and some unconverted carbon. In previous projects, Praxis investigated the utilization of "as-generated" slags for a wide variety of applications in road construction, cement and concrete production, agricultural applications, and as a landfill material. From these studies, we found that it would be extremely difficult for "as-generated" slag to find large-scale acceptance in the marketplace even at no cost because the materials it could replace were abundantly available at very low cost. It was further determined that the unconverted carbon, or char, in the slag is detrimental to its utilization as sand or fine aggregate. It became apparent that a more promising approach would be to develop a variety of value-added products from slag that meet specific industry requirements. This approach was made feasible by the discovery that slag undergoes expansion and forms a lightweight material when subjected to controlled heating in a kiln at temperatures between 1400 and 1700°F. These results confirmed the potential for using expanded slag as a substitute for conventional lightweight aggregates (LWA). The technology to produce lightweight and ultra-lightweight aggregates (ULWA) from slag was subsequently developed by Praxis with funding from the Electric Power Research Institute (EPRI), Illinois Clean Coal Institute (ICCI), and internal resources.

The major objectives of the subject project are to demonstrate the technical and economic viability of commercial production of LWA and ULWA from slag and to test the suitability of these aggregates for various applications. The project goals are to be accomplished in two phases: Phase I, comprising the production of LWA and ULWA from slag at the large pilot scale, and Phase II, which involves commercial evaluation of these aggregates in a number of applications.

Primary funding for the project is provided by DOE's Morgantown Energy Technology center (METC) with significant cost sharing by Electric Power Research Institute (EPRI) and Illinois Clean Coal Institute (ICCI).

1.2 Scope of Work

The Phase I scope consisted of collecting a 20-ton sample of slag (primary slag), processing it for char removal, and pyroprocessing it to produce expanded slag aggregates of various size gradations and unit weights, ranging from 12 to 50 lb/ft³. In Phase II, the expanded slag aggregates will be tested for their suitability in manufacturing precast concrete products (e.g., masonry blocks and roof tiles) and insulating concrete, first at the laboratory scale and subsequently in commercial manufacturing plants. These products will be evaluated using ASTM and industry test methods. Technical data generated during production and testing of the products will be used to assess the overall technical viability of expanded slag production. Relevant cost data for physical and pyroprocessing of slag to produce expanded slag aggregates will be gathered for comparison with (i) the management and disposal costs for slag or similar wastes and (ii) production costs for conventional materials which the slag aggregates would replace. In addition, a market assessment will be made to evaluate the economic viability of these utilization technologies.

1.3 Phase I Task Description

A summary of the tasks performed in Phase I is given below:

- Task 1.1 Laboratory and Economic Analysis Plan Development:** Development of a detailed work plan for Phase I and an outline of the Phase II work.
- Task 1.2 Production of Lightweight Aggregates from Slag:** This task covered selection and procurement of project slag samples, slag preparation including screening and char removal, and slag expansion in a direct-fired kiln and fluid bed expander. The char recovered from the slag preparation operation was evaluated for use as a kiln fuel and gasifier feed. Environmental data for slag-based lightweight aggregate (SLA) production was collected.
- Task 1.3 Data Analysis of Slag Preparation and Expansion:** Analysis and interpretation of project data, including development of material and energy balances for slag processing and product evaluation.
- Task 1.4 Economic Analysis of Expanded Slag Production:** Economic analysis of the utilization of expanded slag was conducted by determining production costs for slag-based LWAs and ULWAs. Expanded slag production costs were compared with the market value of similar products both with and without taking into account the avoided costs of disposal and with the costs of management of slag as a solid waste.
- Task 1.5 Topical and Other Reports:** Preparation topical, financial status, and technical progress reports in accordance with the Statement of Work.

1.4 Phase II Task Description

A summary of the tasks to be performed in Phase II is given below.

- Task 2.1 Test Plan for Applications of Expanded Slags (Field Studies):** This task involves the development of selection criteria and a field test plan for applications of expanded slag. This plan will serve as a guide in the selection and implementation of field demonstrations for the most promising expanded slag utilization applications. Field applications will be selected on the basis of laboratory results, the marketability of the products, and the suitability of the project slags for producing them. The following applications are under consideration for testing:
- ▶ Lightweight concrete blocks made from 50 lb/ft³ SLA
 - ▶ Lightweight roof tiles made from 40 lb/ft³ SLA
 - ▶ Loose fill insulation made from 16 lb/ft³ SLA
 - ▶ Lightweight insulating concrete made from 16 lb/ft³ SLA

Task 2.2 Field Studies to Test Expanded Slag Utilization: Under this task, field testing of the applications identified in Phase II, Task 2.1, will begin with test work to optimize the concrete mixes made from expanded slag.

Task 2.3 Data Analysis of Commercial Utilization of Expanded Slags: The objective of this task is to assimilate the data and test results collected during Phase II, Task 2.2, to convert these findings to common engineering terms, and to correlate these results with comparable information for conventional lightweight aggregates as reported in the literature. The data analysis will provide specific answers to the following issues:

- ▶ Performance of expanded slag compared with that of conventional materials
- ▶ Technical viability of lightweight and ultra-lightweight slags as aggregates.

Task 2.4 Economic Analysis of Expanded Slag Utilization: The objective of this task is to expand upon the preliminary economic assessment of expanded slag utilization conducted during Phase I. The economics will be studied based on the production costs for SLA in comparison with current market prices for conventional materials. During the Phase I preliminary evaluation, two production scenarios emerged:

- ▶ Production of SLA at the gasifier location (on-site production)
- ▶ Production of SLA at a lightweight aggregate facility (off-site production)

The impact of the avoided costs of slag disposal on the economics of SLA production will also be evaluated. Slag utilization data and product samples will be made available to commercial lightweight aggregate users for validation of estimated market prices. The impact of SLA market prices on the economics of SLA production will also be studied.

Task 2.5 Final Report: The data generated and collected during the project will be compiled in a final report to be submitted at the end of the project that will be a comprehensive description of the results achieved, consistent with the Reporting Requirements. Data from topical and field reports will be summarized. The report will include the original hypothesis of the project and present the investigative approaches used, complete with problems encountered or departures from the planned methodology, and an assessment of their impact on the project results.

1.5 Scope of this Document

This is the ninth quarterly report and summarizes the work undertaken during the performance period between 1 September 1996 and 30 November 1996. This is the second quarterly report for Phase II of the project. This document summarizes the Phase II accomplishments to date along with the major accomplishments from Phase I.

2.0 SUMMARY OF WORK DONE DURING THIS REPORTING PERIOD

2.1 Summary of Major Accomplishments

The following was accomplished during the current reporting period:

1. Mix designs for the lightweight block application were prepared. The expanded slag samples were prepared and shipped to a block manufacturer in the Chicago area.
2. An advance sample of Slag III from the Wabash River Plant was collected and evaluated for its expansion characteristics
3. Expanded slag samples were prepared for evaluation in horticultural or nursery applications and sent to a major nursery in Tennessee.
4. Roof tile application data were evaluated.

2.2 Chronological Listing of Significant Events in This Quarter

The following significant events occurred during the current reporting period:

Date	Description
7/15/96	Evaluation of SLA for horticultural applications initiated
7/30/96	Laboratory evaluation of SLA for roof tile concrete completed
10/10/96	Mix designs for block production selected
10/30/96	Structural concrete laboratory tests completed
11/10/96	Laboratory evaluation of Slag III for LWA production completed

3.0 TO DATE ACCOMPLISHMENTS

A summary of the work completed in Phase I is given below.

Date	Accomplishments
10/24/94	Draft Laboratory and Economic Analysis Plan (project work plan) submitted
11/18/94	Slag char removal completed on the advance sample and prepared slag laboratory expansion testing initiated
12/02/94	Final "Laboratory and Economic Analysis Plan" prepared and submitted
05/21/95	Primary slag sample (20 ton) received at Penn State for preparation
06/01/95	Pilot unit for char removal set up and processing work started
08/20/95	Primary slag sample processing for char removal completed
9/10/95	Laboratory expansion studies of slag and slag/clay blends started
10/15/95	1-ft and 3-ft diameter kilns commissioned for pilot testing
11/15/95	Pilot testing of Slag I and Slag II and pellets in 3-ft dia. direct-fired kiln completed
11/17/95	Pilot testing using fluidized bed expander completed
12/12/95	SLA product characterization initiated
1/20/96	Laboratories for testing of SLA products identified
2/16/96	Test plan for second batch of fluid bed expander testing at Fuller completed
4/30/96	Application for continuation of the project to Phase II submitted
5/31/96	Phase I Final Report (draft) submitted to METC

A summary of the work completed in Phase II to date is given below.

Date	Description
7/1/96	Phase I Topical Report (final version) submitted
7/14/96	Structural concrete laboratory tests started
7/15/96	Lab testing of SLA for roof tile & insulating concrete applications completed
7/28/96	Manufacturer for block production selected
7/15/96	Evaluation of SLA for horticultural applications initiated
7/30/96	Laboratory evaluation of SLA for roof tile concrete completed
10/10/96	Mix designs for block production selected
10/30/96	Structural concrete laboratory tests completed
11/10/96	Laboratory evaluation of Slag III for LWA production completed

4.0 TECHNICAL PROGRESS REPORT

4.1 Manufacture and Testing of Masonry Blocks

The objective of this subtask is to use commercial-scale concrete block manufacturing equipment and techniques to produce blocks from expanded slag. This work is being done at the facilities of Harvey Cement Company, a major block manufacturer and distributor in the greater Chicago area. Harvey Cement was selected as they are located close to the recently commissioned Wabash River IGCC plant which is potentially a permanent source of slag and slag LWA. A number of block mix designs were developed by Praxis based on particle size distribution and unit weight information provided by Harvey Cement. These mix designs will be tested in the laboratory to optimize them. Harvey will initially prepare trial batches of concrete, followed by a full-scale production run using their commercial batching plant and continuous block machine.

Mix designs were prepared with the objective of using an optimum proportion of slag LWA to control the total weight of the block while maintaining the proportions of other aggregates in accordance with current practice. Since manufacturers can choose from a variety of aggregates, mix designs were developed to test a number of different blends. Table 1 provides the size distribution of the aggregates used by Harvey Cement, along with that of the coarse SLA (SLA/C) produced from a coarse (1/4" x 10M) slag feed and the fine SLA (SLA/F) produced from a 10 x 50M slag feed. Material size gradation is critical as it determines the workability of the block mix. Mix designs, shown in Table 2, were formulated taking care to conform to the guideline size gradation range provided by the manufacturer. Based on these guidelines, five mix designs (SLA Mix Nos. 1 through 5) were selected for testing and provided to the manufacturer for evaluation. They have reviewed them and scheduled the tests for January 1997. Samples of SLA/C and SLA/F have arrived at their facility from Fuller, and the other materials needed are available in sufficient quantities.

4.2 Laboratory Evaluation of SLA for Structural Concrete Application

The objective of this test program is to develop mix designs to produce sand and SLA-based cement concretes with a compressive strength of 2500-4000 psi and corresponding unit weights in the 115-105 lb/ft³ range. This can be accomplished by varying the proportion of cement relative to the SLA. The tests were completed recently and the results are awaited from the laboratory.

Table 1. Size Distribution of Various Aggregates and Block Mixes

Cell No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Material	Haylite	LSS	SS	No. 2 TS	Fine Sand	SLA/F	SLA/C	Mix No. 25	Mix No. 28	Mix No. 19	SLA No. 1	SLA No. 2	SLA No. 3	SLA No. 4	SLA No. 5
Size Interval	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%
+3/8"	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.7	0.0	1.8	0.0	0.9
3/8" x 4M	0.9	2.1	12.8	0.2	0.0	0.5	8.7	4.6	1.8	1.4	3.4	0.9	4.8	4.5	5.6
4 x 8M	16.6	34.6	24.8	10.7	0.0	9.2	61.5	28.6	30.2	24.4	23.3	16.2	38.7	14.7	26.5
8 x 16M	27.9	28.8	20.6	14.9	0.0	54.8	24.1	26.5	26.2	28.3	25.2	33.5	19.3	29.8	28.6
16 x 30M	20.0	12.6	15.4	30.4	0.0	23.0	1.1	14.8	15.9	16.8	16.7	19.1	6.1	22.7	17.5
30 x 50M	13.5	6.8	11.6	38.4	2.0	10.8	1.1	9.3	12.5	10.6	15.9	14.2	6.1	20.1	15.5
50 x 100M	8.2	5.5	8.0	5.3	10.0	1.5	0.0	6.6	5.4	7.0	4.2	4.3	3.6	4.9	3.7
100M x 0	2.9	9.7	6.8	0.2	88.0	0.2	0.0	9.6	8.0	11.5	10.5	11.8	19.6	2.4	1.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.0	100.0
Unit Wt., lb/ft ³	50.0	88.6	87.3	110.0	110.0	43.9	44.7								

Table 2. Aggregate Mix Proportions (Volume Percent)

Cell No.	ID	8	9	10	11	12	13	14	15
Ingredients		Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%	Vol%
Haylite	1	19.5	0.0	56.7	0	0.0	0	0.0	0.0
L.S Screenings	2	55.2	81.8	43.3	10.0	30.0	20	0.0	0.0
Slag Sand	3	25.3	0.0	0.0	10.0	0.0	0.0	33.0	25.0
No. 2 T Sand	4	0.0	18.2	0.0	30.0	20.0	10.0	33.0	25.0
Fine Sand - 100M	5	0.0	0.0	0.0	10.0	10.0	20.0	0.0	0.0
SLA/F (10 x 50M)	6	0.0	0.0	0.0	20.0	40.0	0.0	33	25.0
SLA/C (1/4" x 10M)	7	0.0	0.0	0.0	20.0	0.0	50.0	0.0	25.0
Total		100.0	100.0	100	100.0	100.0	100.0	99.0	100.0
Unit Weight, lb/ft ³ (calc)		80.7	92.5	66.7	79.3	77.1	73.1	79.6	71.5

4.3 Laboratory Evaluation of Slag III as a Feed Material for LWA Production

A third slag sample (Slag III) was obtained from the Wabash River Repowering Project IGCC plant. This slag was added to the project with the objectives of (i) extending the project findings to another slag, and (ii) producing a batch of SLA suitable for structural applications, with higher strength than those produced from Slags I and II. In order to achieve higher strength, the new SLA products will be generated at unit weights of 50-55 lb/ft³.

Prior to testing Slag III for its expansion characteristics, its basic physical and compositional characterization was analyzed using a 5-gallon slag sample shipped to Fuller Company. The results of the physical characterization, including unit weight, angle of rupture, and size gradation, are given in Table 3, and the complete oxide analysis is presented in Table 4. The composition of Slag III is generally the same as that of a number of other slags. However, its loss on ignition (which represents its carbon content) is lower than that of the other slags tested.

Table 3. Slag III Particle Size Distribution (As Received)

Unit weight, wet (lb/ft ³)	57.8
Unit weight, dry (lb/ft ³)	72.1
Angle of rupture, loose	65°
Angle of rupture, packed	90°
Moisture, %	12
Cumulative Percent Passing	
3/8"	100.0
1/4"	99.7
4 mesh	99.0
6 mesh	95.6
8 mesh	86.6
12 mesh	74.0
16 mesh	54.8
20 mesh	39.3
30 mesh	28.8
40 mesh	20.6
50 mesh	14.0
70 mesh	9.0
100 mesh	6.1
140 mesh	4.4
170 mesh	3.8
200 mesh	3.3
325 mesh	2.2

Table 4. Slag III Compositional Analysis as Oxides (Weight Percent Dry Basis)

Sample	Slag III As Received	Fired Pellet 50% Slag III/50% Clay
Loss at 105°C	12.0	---
SiO ₂	42.9	53.7
Al ₂ O ₃	16.5	18.5
Fe ₂ O ₃	14.2	12.31
CaO	9.1	6.8
MgO	1.16	2.0
K ₂ O	2.17	2.5
Na ₂ O	0.73	0.4
SO ₃	1.45	0.08
P ₂ O ₅	0.13	0.15
TiO ₂	0.81	0.83
Mn ₂ O ₃	0.09	0.14
Loss at 900°C	10.3	2.26
Total	99.6	99.7

Laboratory Expansion Test Objectives. In Phase I, a number of laboratory- and pilot-scale studies were performed to determine the feasibility of producing LWA products from gasifier slag samples in both discrete particle and extruded form. Using a similar approach, Slag III was subjected to an initial laboratory-scale evaluation to determine the feasibility of proceeding with pilot-scale fluidized-bed expansion testing for this slag. The objectives of these tests were to:

- ▶ Evaluate the feasibility of producing lightweight aggregates with unit weights in the 40-55 lb/ft³ range from Slag III in discrete particle form
- ▶ Evaluate the feasibility of producing lightweight aggregates (<55 lb/ft³) from an extruded blend of 50% Slag III/50% clay
- ▶ Determine the relationship between lab furnace temperature and product unit weight.

Samples of "as-received" Slag III in discrete particle form were fired in a lab furnace without making any adjustments to the size gradation or chemistry. A portion of the material was dried and then ground to -50 mesh. The ground material was combined with dry -50 mesh clay and then extruded following adjustment of the moisture level to 21.4%. These extrusions demonstrated excellent strength following drying, and appear to be suitable for rotary kiln processing in pellet form, or suitable for granulation to produce a feed for fluidized-bed processing to make lightweight aggregates.

Slag Sample Expansion Test Procedure. In order to study the expansion characteristics of Slag III, approximately 150 g of the material was placed on a 5" diameter ceramic dish and inserted

into an electric muffle furnace held at a temperature of 1000°F for a period of 15 minutes in order to preheat the sample. The sample was then immediately transferred to a high-temperature furnace and retained for a period of 15 minutes, cooled using ambient air, and weighed to determine the total loss and product unit weight. The atmosphere in both processes was air @ 21% O₂/79% N₂. These tests were run at temperatures ranging between 1500-1700°F for the discrete particles and 1800-2000°F for the pellets.

Discrete Particle Firing Test Results. The test results, presented in Table 5, indicate that it is feasible to produce a lightweight aggregate product with a density ≤ 40 lb/ft³ from discrete particles of Slag III or 50/50 Slag III/clay extrusions. A fired product with a low unit weight of 22.1 lb/ft³ was produced from Slag III particles at a temperature of 1600°F. Results indicate that a 30-40 lb/ft³ expanded product could be produced at temperatures below 1500°F. Figure 1 illustrates the relationship between the expanded product unit weight and furnace temperature. The curve indicates that the minimum density is achieved at a temperature of approximately 1600°F, with the density increasing at higher temperatures. Product densification occurred at 1700°F and was accompanied by weak-looking agglomerates. Sulfur emissions from the material were detected at all temperatures evaluated. Observations made during the laboratory-scale furnace evaluations included popping and cracking of the material upon entry into the preheat furnace, which continued through the phase. This is attributed to the carbon (char) content of the slag. Following the completion of the burn, weak particle agglomeration was observed, but the material did not stick to the ceramic dish. The larger particles at the top of the sample were brown, while those deeper in the sample were a glossy black, and the finer particles were a light tan color. A strong sulfur smell was present after the burn. This indicates that it will be necessary to separate the char from this slag, as is the case with the other slags.

Pelletized Material Test Results. A significantly higher laboratory furnace temperature of 1950°F was required to produce a fired product which had a unit weight of <40 lb/ft³ from a pelletized blend of 50/50 Slag III and clay. The lowest unit weight (28.8 lb/ft³) was obtained at a temperature of 2000°F. While the curve in Figure 1 indicates that the unit weight could be further reduced at temperatures of $>2000^\circ\text{F}$, the formation of hard agglomerates and surface melting appear to limit the process temperature to 2000°F. As with the discrete particles, sulfur emissions from the material were detected at all temperatures evaluated including the preheat phase.

The preheated pellets were light black/dark gray in color. The fired pellets were a light brown/purple color, and the brown layer could be easily chipped away to expose the glossy black porous core. It appeared that the outer layer was separated slightly from the core. The agglomerated pellets could be broken apart after cooling. In the case of the pelletized slag blend, also, removal of the char would be beneficial for the expansion process.

Characterization of Expanded Slag/Clay Pellets. As a part of the overall compositional characterization, a complete oxide analysis of the fired expanded slag pellets was conducted. The results are given in Table 4 above. The composition of the 50/50 slag pellets is somewhat different from that of the slag due to the composition of the clay.

Table 5. Slag III Laboratory-Scale Expansion Data

Firing Temp, °F	Unit Wt lb/ft³		Volume Expansion	Sample Weight, g		Weight Loss, %	Feed Moisture, %
	Feed	Product		Start	Final		
50% Slag III/50% Clay Pellets							
1800	61.4	45.2	1:1	139.3	102.6	26.3	21.4
1900	62.0	45.9	1:1	140.5	104.0	25.9	21.4
1950	55.9	35.5	1:1.1	126.7	92.0	27.4	21.4
2000	59.8	28.8	1:1.5	135.7	99.3	26.8	21.4
Slag III Discrete Particles							
1500	70.2	25.6	1:2.33	159.5	151.5	5.0	12.0
1600	67.0	22.1	1:2.9	152.0	143.6	5.5	12.0
1700	68.8	23.9	1:2.9	156.1	146.2	6.3	12.0

The results of the pilot study indicate the feasibility of producing an LWA product from Slag III in both discrete particle form and as 50/50 Slag III/clay pellets. The expansion results for the Slag III discrete particles indicate the potential to produce an ULWA product. Additional testing is needed to further evaluate the commercial feasibility of using a dynamic pilot fluidized-bed or a rotary kiln for this purpose.

4.4 Laboratory Evaluation of SLA for Roof Tile Application

Various lightweight concrete mix designs using SLA as a substitute for LWA were formulated in the previous quarter to make test specimens. Laboratory experiments were conducted using varying amounts of accelerator, superplasticizer, and water/cement (w/c) ratios with the goal of obtaining the highest 7-day compressive strength without the use of excess additives. Three 2" x 2" x 2" mortar cubes were cast and cured in a wet box (relative humidity of ~70%) for 2 hours, then steam-cured at ~60°C for 4 hours, and tested for their compressive strength and unit weight. The 7-day compressive strength of roof tile concrete made from 50% SLA was 2800 psi. This is close to the value obtained for the clay control sample at 3390 psi but lower than that of a sample supplied by a commercial roof-tile manufacturer which had a compressive strength of 4789 psi.

While the strength of the slag-based concrete is considerably lower than that of similar products made from conventional lightweight aggregates, its unit weight at 97.4 lb/ft³ is also lower than that of manufactured aggregate-based concrete at 102-105 lb/ft³. Therefore, we are exploring the possibility of producing another batch of SLA with a higher unit weight to increase its compressive strength. The bulk of the product evaluation tests will be conducted after the new batch has been produced.

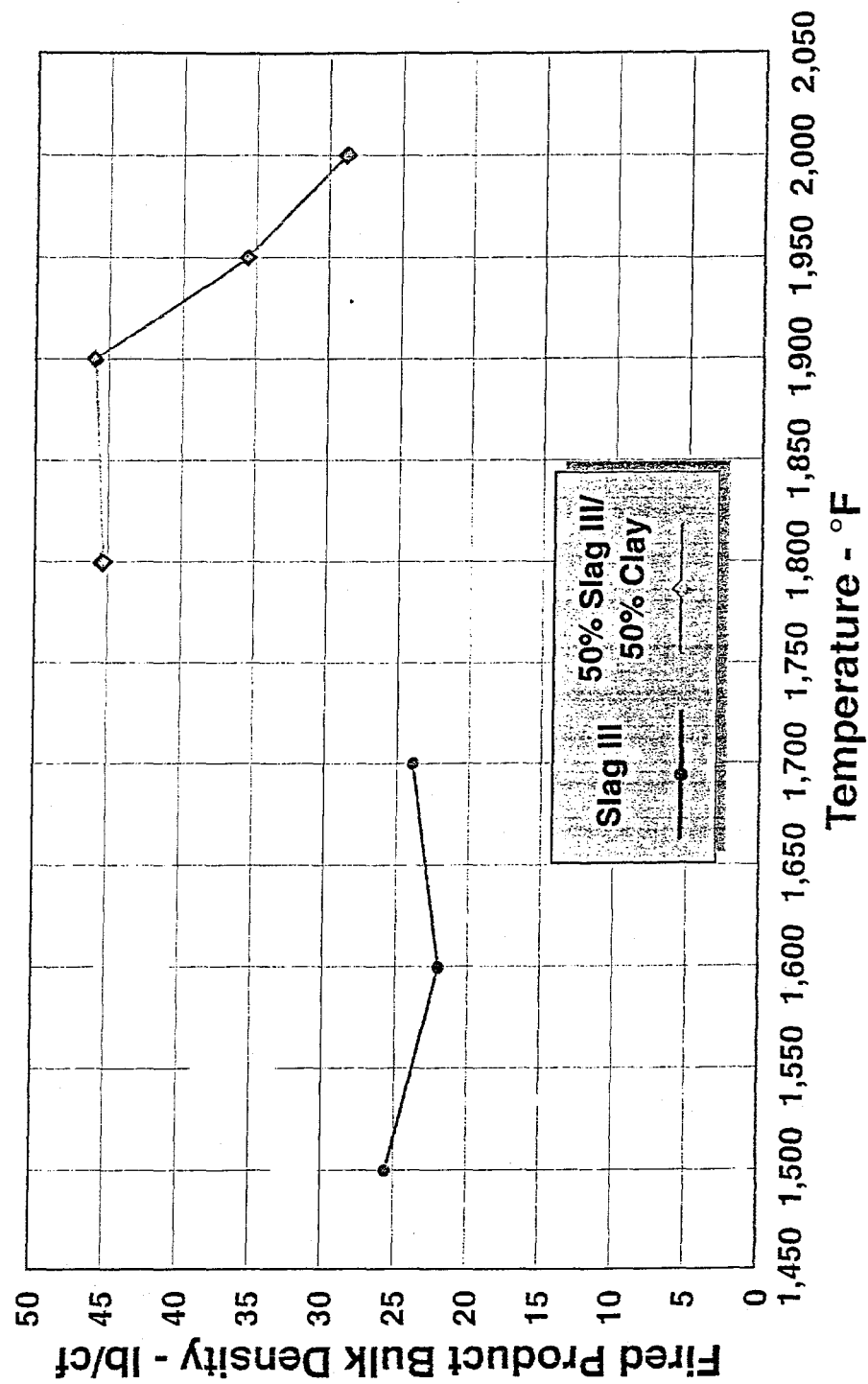


Figure 1. Fired Product Density vs. Furnace Temperature

4.5 Utilization of SLA for Horticultural Applications

Samples of SLA with unit weights of ≤ 20 lb/ft³ were sent to a nursery in Tennessee for evaluation. Their initial assessment is that the material may be more suitable for outside landscaping than for potted plants due to its strength. Mixes will be prepared using SLA, peat moss, saw dust, and other materials and tested during the next growing season.

4.6 Conclusions and Recommendations

The results of the laboratory tests for the roof tile application indicated that a higher aggregate strength is desirable. We are planning to produce another batch of SLA to meet these requirements.

Preliminary results from the horticultural application for low-unit-weight SLA indicate that it may be well suited for outside landscaping. Therefore, SLA mix designs are being prepared for testing in the next growing season.

Based on laboratory-scale studies to determine the feasibility of producing lightweight aggregates from Slag III, it was determined that it is feasible to produce lightweight aggregate products with unit weights of ≤ 40 lb/ft³ from Slag III in both discrete particle form and after blending with 50% clay and extruding.

A fired product with a low unit weight of 22.1 lb/ft³ was produced from Slag III particles at a lab furnace temperature of 1600°F. Results indicate that a product with a unit weight in the 30-40 lb/ft³ range could be produced at temperatures of $< 1500^\circ\text{F}$. Weak agglomerates were observed at temperatures of $\geq 1600^\circ\text{F}$. A significantly higher furnace temperature of 1950°F was required to produce a fired product with a density < 40 lb/ft³ (35.5 lb/ft³) from a 50/50 blend of Slag III and clay. A minimum density of 28.8 lb/ft³ was obtained from the 50/50 pellets at a temperature of 2000°F. Hard agglomerates and surface melting were observed at 2000°F.

The following conclusions were drawn from the test work conducted on Slag III:

- ▶ Char removal is important for expansion of this slag, as identified for other slags
- ▶ Additional testing is recommended to further evaluate the commercial feasibility of utilizing a dynamic pilot fluidized-bed or rotary kiln processing.

5.0 PLAN FOR THE NEXT QUARTER

The following activities are planned for the next quarter:

- ▶ Complete laboratory evaluation of expanded slag products for horticulture applications
- ▶ Evaluate the block application at the laboratory scale and make a batch of lightweight blocks using SLA
- ▶ Prepare plan for other applications testing at the commercial scale.